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NAVAL SURFACE WARFARE CENTER TECHNOLOGY TRANSFER REPORT (FY88)

BY RAMSEY D. JOHNSON

CENTER PLANNING STAFF

1 OCTOBER 1988

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NAVAL SURFACE WARFARE CENTER

Dahlgren, Virginia 22448-5000 • Silver Spring, Maryland 20903-5000

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This report describes the Naval Surface Warfare Center Technology Transfer Program and presents narrative summaries of related projects performed during FY88. A Technology Application Assessment and a listing of patents/Navy cases having commercial potential are also presented.

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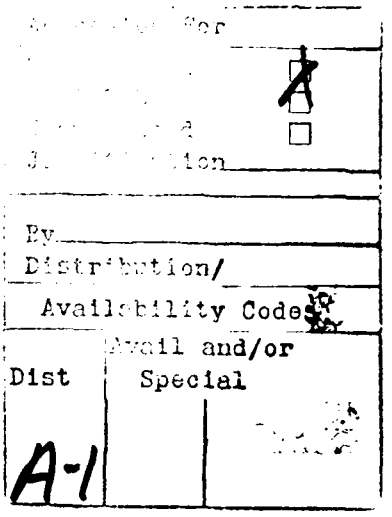

FOREWORD

The Naval Surface Warfare Center (NSWC) Technology Transfer Report (FY88) has been prepared in accordance with the format and content formulated by the Office of Naval Technology for Navy inputs in meeting the reporting requirements of the Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 96-480) as amended by the Federal Technology Transfer Act of 1986 (Public Law 99-502).

The objectives of Navy domestic technology transfer are (1) to disseminate non-critical technology, originally developed in support of military applications, for potential alternative uses in the public and private sectors; and (2) to promote joint cooperative development programs that address problems of mutual concern to the Navy and other agencies or organizations. In pursuit of these objectives, the Navy transfers technical expertise to other Federal Government agencies; state and local governments; small and large businesses; nonprofit organizations; and such public service organizations as schools, hospitals, and foundations. In addition, technologies that have direct impact on the Navy mission and programs are transferred within, or into, the Navy. Transfers of hardware, software, management practices, and expertise are made in diverse fields, such as analysis and testing, communications, energy, environment, transportation, and marine technology. The Navy Domestic Technology Transfer Program provides unique services not available from, or in competition with, the private sector. Content is limited to non-militarily critical technical material that is approved for public release.

The transfer process functions as a "two-way street" and thus also serves to infuse the Navy R&D community with new ideas, techniques, and information from outside sources. The underlying philosophy and approach of this report are to derive national benefits through technology transfer by capitalizing on recent scientific developments to promote technical and economic growth within the U.S.

A substantial portion of the information in the Appendices of this report was contributed by NSWC technical staff members engaged in Center technology transfer tasks. Questions or requests for additional information should be referred to NSWC, Code D21, Mr. Ramsey D. Johnson, (301) 394-1505 or Autovon 290-1505.

Approved by:

D. B. Colby

D. B. COLBY
Associate Technical Director

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1. ORGANIZATIONAL STRUCTURE FOR TECHNOLOGY TRANSFER

a. Background. From a historical perspective, NSWC has been involved in technology transfer activities even prior to participating as a charter member of the Department of Defense Technology Transfer Consortium in 1971. This organization has subsequently evolved into the Federal Laboratory Consortium, of which NSWC continues to be a contributing member. NSWC's role is necessarily limited since its R&D efforts are principally directed toward Navy requirements in the national security arena. Consequently, considerations of security classification and export control of unclassified critical technologies can severely constrain the release of technical information on an unrestricted basis. Furthermore, the work is often intrinsically oriented to naval applications, and considerable adaptive engineering (necessitating non-DoD funding sources and redirection of in-house resource allocations from mission areas) would be required to redirect the R&D to non-Navy uses. Within these general constraints, NSWC endorses and pursues technology transfer activities involving Center-wide R&D efforts.

b. Program Implementation.

(1) Management. The Center's domestic technology transfer policy is administered by the Center Planning Staff (Code D21). The staff provides advanced planning information on matters impacting the role, mission, and long-term commitments of the Center. Policy implementation vehicles for technology transfer include the Center's Office of Research and Technology Applications (ORTA), the Navy Potential Contractor Program, and the Federal Laboratory Consortium for Technology Transfer. The Industry Independent Research and Development (IR&D) Program is also a contributor to technology transfer activities, since the transfer process can involve a two-way exchange between Government and non-government organizations. The IR&D Program serves to inform government technologists about industry-initiated research and it also serves as a mechanism for government researchers to appraise the progress and relevance of industry-initiated efforts. Guidance regarding technology transfer constraints is provided by the Militarily Critical Technologies List (MCTL), and the Center contributes to the technical review of export license applications received by the Navy Office of Technology Transfer and Security Assistance (NAVOTTSA). Technology transfer management functions include:

(a) managing the program within the Center;

(b) maintaining external liaison (with the Office of the Chief of Naval Research, the Federal Laboratory Consortium for Technology Transfer, the Department of Commerce, other Federal agencies, state and local governments, universities, and private industry);

(c) preparing Technology Application Assessments;

(d) assisting potential user organizations in formulating their problems;

(e) providing and disseminating information on federally owned or originated products, processes, and services having potential application to state and local governments and private industry;

(f) providing technical assistance in response to requests from state and local governments;

(g) functioning as Center manager for MCTL matters; and

(h) serving as Center manager for review of Navy-related export license applications.

(2) Technical Effort.

(a) Project Work. Directly attributable and quantifiable technology transfer work performed by Center technical departments is generally represented by those projects funded by other Government (non-DoD) sponsors and private parties (excluding that effort funded under DoD contracts). This type of effort, identified as project work, has manpower and funding allocations that are directed towards a specific objective or requirement per sponsor request.

(b) Technological Disclosures. In its role as a major Government R&D center, NSWC also serves as a significant contributor to Federal technology transfer in a more generic nature via technological disclosures in the open literature such as patents, reports, journals, and participation in symposia. The benefits from this type of activity accrete as spin-offs from DoD mission-related projects that are supported by Federal R&D appropriations. Although it is less tangibly measurable than technology transfer contributions of direct project work involving end-products, the long-term benefits are more highly promising since they provide the innovative community with a broad spectrum of new stimuli to promote economic, technical, and quality-of-life growth in the private and public sectors.

(3) Navy-wide Services. The Center also manages, edits, and publishes the "Navy Domestic Technology Transfer Fact Sheet." This monthly publication highlights Navy-wide technology and developments that have the appropriate approval for public release and are of potential benefit to public and private organizations, individuals, and other Federal laboratories. The program is sponsored by the Office of Naval Technology (Code ONT-263) to provide a highly visible source and focus for the dissemination of domestic technology transfer contributions from the Navy laboratory community.

c. Program Funding Source. A summary of FY88 funding support for management activities and project work performed by the Center is presented below:

	FY88 ($K)
(1) Administrative Functions	
ORTA	25
Other Technology Transfer	25
Technical Publications Division	180

	FY88 ($K)
(2) Technical Projects	
Engineering Department	400
Research and Technology Department	270
Underwater Systems Department	10
Total	910

d. The following technology transfer related policy directives are in effect at NSWC:

(1) NAVSWCINST 5700.2A of 6 Jan 1986; Subj: Office of Research and Technology Applications (ORTA). The purpose of this instruction is to establish the Center ORTA.

(2) NAVSWCINST 3900.3 of 13 October 1981; Subj: Industry Independent Research and Development (IR&D) Program.

(3) NAVSWCINST 3900.1A of 22 December 1981; Subj: Navy/Industry Cooperative Research and Development (NICRAD) Program [now known as Navy Potential Contractor Program (NPCP)]. The purpose of this instruction is to establish procedures for processing NICRAD agreements in accordance with NAVMATINST 3900.14. The NICRAD Program is technically not an element of the Navy's Domestic Technology Transfer Program. Frequently it involves the exchange of sensitive and classified information to authorized contractors. Nevertheless, transfer of technology is involved. Therefore, for administrative purposes this program is included as a functional element of the NSWC Technology Transfer Program.

e. The Center manager for ORTA/Technology Transfer, the IR&D Program, and NPCP is Mr. Ramsey D. Johnson, Code D21, (301) 394-1505 or Autovon 290-1505.

2. ACCOMPLISHMENTS AND CURRENT EFFORTS SUMMARY

a. Narrative summaries of NSWC technology transfer related projects involving FY88 effort are presented in Appendix A.

b. The following report, which describes recent Center accomplishments, efforts, and technology transfer related resources, was published for public release:

NSWC MP 88-14, Naval Surface Weapons Center Technology Transfer Report (FY87).

c. One FY88 Technology Application Assessment was submitted to the Office of the Chief of Naval Research as input for the Department of Commerce, National Technical Information Service. This item involves nickel battery electrode technology and is described in Appendix B.

3. INFORMATION DISSEMINATION AND WORKING RELATIONSHIPS

a. NSWC is a member of the Federal Laboratory Consortium for Technology Transfer and participates in meetings, symposia, and exhibits related to technology transfer activities involving the Navy, state and local governments, and private industry.

b. NSWC publishes and contributes to the "Navy Domestic Technology Transfer Fact Sheet." FY88 inputs to this document are listed below:

(1) NSWC Develops New Electro-Mechanical Transducer

(2) Scientists Receive Cash Awards for Invention

c. NSWC has prepared an exhibit to publicize and promote the "Navy Domestic Technology Transfer Fact Sheet." This exhibit is displayed and manned at conventions such as the American Society for Naval Engineers (ASNE) and the National League of Cities. New subscribers are identified to expand the diverse range of scientists, engineers, and municipalities which participate in the information exchange medium. In FY88, the exhibit was presented at the following conventions:

(1) National League of Cities; Las Vegas, Nevada; December 1987

(2) National Petroleum Engineers Conference; October 1988

d. NSWC entered into the following NPCP Agreements in FY88:

	Company	Agreement Title
(1)	Martin Marietta Baltimore Aerospace	Hardkill/Softkill Requirements Study
(2)	RCA/Electronic Systems Department	Assessment of Using an IRST as a Queing Device for Radars
(3)	SET Industries, Inc.	Application of Reverse Engineering Study to CMS-2
(4)	Bendix Oceanics Division	ASW Deep Moor Mine
(5)	Texas A&M Research Foundation	Intelligent Control Systems for Autonomous Underwater Vehicles
(6)	Sippican	Bought by Foreign Company--Agreement not in Effect
(7)	Westinghouse Electric Corporation	Short Range AAW Combat System Concept Investigations
(8)	AAI Corporation	High Pulsed Power Generation

	Company	Agreement Title
(9)	General Research Corporation	NATO Anti-Air Warfare (AAW) System
(10)	Rockwell International	Anti-Tactical Missile Seeker
(11)	Republic Electronics	NATO AAW Controlled Target/Sea Clutter Environment Generator
(12)	Coleman Research Corporation	Missile System Engineering Analysis
(13)	Loral Systems Group	Warhead/Sensor Fuzing Study
(14)	Hughes Aircraft Company, Electro-Optical and Data Systems Group	Dynamic Targeting Tracking
(15)	Loral Systems Group, Akron	Advanced Sensor Systems for ASW Mines
(16)	Damaskos, Inc.	Infrared Study
(17)	EDO Corporation, Western Division	Sensor Improvement Study
(18)	SI/Division of SPECTRUM	Lightweight Armor or Quarterdeck Ballistic Shield
(19)	Applied Research and Science	Sensor Technology Review
(20)	Bell Aerospace/TEXTRON	AAW Horizon Search Radar Analysis
(21)	D. R. Kennedy and Associates	Navy R&D Requirements Study
(22)	Magnavox Electronic Systems Company	Performance Comparison of Detection Algorithms for Use in Mines

e. In FY88, there were 25 inventions and patent disclosures by NSWC with potential technology transfer applications. These are listed in Appendix C. NSWC also contributed approximately 550 unrestricted information disclosures via various media such as symposia, workshops, journals, and other publications.

f. In 1988, 35 NSWC technical publications were entered into the National Technical Information Service (NTIS) data base.

g. In support of government and academic institutions, the NSWC ORTA responded to requests for technical information from the following organizations:

(1) Oak Ridge Associated Universities (materials, ceramics, composites)

(2) Center for Innovative Technology/Virginia Community Colleges (materials testing: composites)

(3) Consumer Product Safety Commission (swimming pool safety: detectors)

(4) University of Texas, Austin (radiation measurement: digital dosimeter)

(5) University of Texas, Austin (pollution control: electrostatic flyash filtration)

h. The NSWC ORTA responded to technical information requests from individuals and private industry in the following technology areas:

(1) Ceramic materials

(2) Battery electrodes

(3) Pollution control (electrostatic flyash filtration)

(4) Software reliability analysis

(5) Eddy current non-destructive inspection

(6) Blasting research (pressure transducers)

(7) Hydroballistics (testing/capabilities)

(8) Testing facilities

(9) Test and evaluation processes/standards

(10) Environmental effects

(11) Magnetostrictive materials

(12) Radiant (LASER) initiation

(13) Radiation monitoring (digital dosimeter)

i. Numerous inquiries are made directly to Center staff members within the various technical departments. The resultant responses significantly contribute to the Center's technology transfer process, although they are not identified and reported individually within the formal ORTA function.

APPENDIX A

NARRATIVE SUMMARIES FOR NSWC FY88 TECHNOLOGY TRANSFER RELATED PROJECTS

1. MANUFACTURING TECHNOLOGY

a. The Navy Manufacturing Technology Program requires that technology transfer to the private sector and Government agencies be a major activity of each funded project. Accordingly, upon completion each project is required to have an end-of-project demonstration for potential users or vendors, and to issue a final report. In both instances, efforts are made to disseminate the information to the widest possible audience. However, some of the information is classified and some is unclassified but all is associated with critical, sensitive technologies. This information is not releasable for public information and such requests are individually assessed based on distribution restrictions. Each project manager is encouraged to actively communicate with interested parties during the project to transfer the developing technology.

b. In addition to technical project work, NSWC also provides technical and administrative program support to the Office of Naval Acquisition Support; the Naval Sea Systems Command; and the Office of the Assistant Secretary of the Navy, Shipbuilding and Logistics (OASN, S&L) for manufacturing technology programs in cost benefit tracking and combat systems.

c. The following Manufacturing Technology programs are ongoing at NSWC:

(1) Cast Projectile Demonstration Program

(2) Metal Matrix Composites (MMCs)
(Discontinuous MMCs for space structures applications)

2. SPACE SHUTTLE STUDY

NSWC accepted a task from NASA (Marshall Space Flight Center) to evaluate the Space Shuttle Range Safety System (RSS) performance, to predict the theoretical breakup phenomena, and provide debris catalogs for NASA's evaluation of debris footprints. The principal phases of the study are to:

a. Provide a breakup analysis of the Solid Rocket Booster (SRB) independent of interaction with the External Tank (ET), and also investigate SRB/ET interaction.

b. Use these airblast and fragmentation effects to analyze the total damage to the ET. This information will support a decision regarding the necessity of retaining the ET RSS.

3. UNDERWATER EXPLOSION EFFECTS ON MARINE LIFE

a. Oil drilling platforms located in navigable waters should be removed after they have served their purpose. Left in place, they present obstructions to general navigation, as well as to net fishing operations. The process of removal is most efficiently begun by explosively severing their legs some distance beneath the ambient bottom. An explosive charge is detonated inside the hollow supports that descend into the sea bottom. This operation should be carried out with little or no deleterious effect on local marine life.

b. Under Department of Interior sponsorship, NSWC initiated a project in FY87 to analyze underwater explosive measurements to help identify the threat to marine life found near oil platform legs. The investigation includes scale model tests for comparison of confined and unconfined explosive effects. In FY89 NSWC will complete analysis of several hundred underwater pressure-time recordings to be obtained during a Gulf of Mexico platform removal operation.

4. TOURMALINE GAGES

a. The original tourmaline gage was designed and developed under Navy contract at Woods Hole Oceanographic Institute during World War II. These gages are used to measure shock wave phenomena from underwater explosions. After the war, scientists formed Crystal Research Company to market the gage; the company closed in 1972. NSWC purchased the company assets and began producing gages to fill the void left by the defunct company. Improvements have been made to the gages in relation to evolving technology.

b. NSWC constructs and calibrates the gages which are sold at fixed price to various Government and industry research activities. Gages and related information are exchanged with foreign governments with whom the U.S. has information exchange agreements. Gage purchasers in FY86, FY87, and FY88 include the Department of Interior (Bureau of Mines), Elda Trading Corp., Battelle, IREECO Chemicals, Gulf Oil Chemicals, West Coast Shock Facility, Total Electronics, M.G. Associates, and Safety Consulting Engineers.

5. PARACHUTE TECHNOLOGY CONSULTATIONS

a. In FY88, NSWC contributed consulting services and, in some cases, technical assistance to the following industrial firms/university in the areas of aerodynamics, structures, packing, and deployment:

(1) TASC, Inc.

(2) EPIC Engineering, Inc.

(3) IDMPC Company

(4) University of Minnesota

b. NSWC published the following report related to parachute technology:

(1) Notes on a Theoretical Parachute Opening Force Analysis Applied to a General Trajectory, NSWC TR 88-6, May 1988.

6. SYSTEMS RESEARCH CENTER AT VIRGINIA POLYTECHNICAL INSTITUTE AND STATE UNIVERSITY (VPI&SU)

a. In 1983, NSWC; the Naval Sea Systems Command (NAVSEA), Combat Systems Directorate (SEA-06); and VPI&SU established the Systems Research Center (SRC) at the university. The SRC is intended to augment the technology base of NSWC in serving the research and development needs of surface combat systems, recognizing that the benefits derived can extend to subsurface and air platforms as well. The SRC has also expanded the technology base for other U.S. Navy R&D activities serving the research and development needs of surface combat systems. The SRC, NSWC, and NAVSEA's (SEA 06) joint effort emphasizes computer science and computing technology, key elements in modern naval applications. The SRC was established to perform only research and development.

b. Since it's establishment, the SRC has received nearly $3.85 million to perform 45 separate tasks. In Fiscal Year 1988, there were 12 active tasks with the SRC. Of these, 6 began in FY87 and 6 in FY88. Of the 12 projects, NSWC sponsored 7 at a cost of about $720K.

7. COMPUTER SCIENCE RESEARCH CONSORTIUM

a. The Computer Science Department at VPI&SU has formed a Computer Science Research Consortium (CSRC) program. This program strengthens existing interactions and creates new professional interactions between VPI&SU professors, the Government, and the industry technical community. NSWC is a member of this consortium and provides a representative for CSRC's steering committee. Mutual benefits of the program include:

(1) Providing a resource of quality graduates to academia, industry, and Government

(2) Promoting Government/academia personnel exchanges

(3) Providing feedback for orienting teaching requirements toward real-life applications

(4) Providing an increased awareness of outside requirements to help focus academic research efforts.

b. During 1987, the Consortium sponsored the following events that promoted technology transfers:

(1) A semiannual newsletter containing articles on current research activities

(2) A two-day satellite TV course titled "User Interface Strategies 88" on 5 and 12 October 1988.

(3) A catalog of technical reports from VPI&SU's Computer Science Department.

APPENDIX B

NSWC FY88 TECHNOLOGY APPLICATION ASSESSMENT

Title	Lab No.
Lightweight Nickel Composite Electrode	NSWC-TAA-88-001

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) ROBERT D. HEIDENREICH
   Phone 202-394-4332 Autovon 290-4332

3. Address Silver Spring, MD 20903-5000 (Code D21)

4. Technology Name Lightweight Nickel Composite Electrode

5. Technology Type: (a) Process (b) Apparatus (c) Material
   (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government
   (c) Local Government (d) Small Industry (e) Medium Industry
   (f) Large Industry (g) Consultant (h) Other: _____

A. Date: 30 September 1988
B. CUFT #:
C. LAB #: NSWC-TAA-88-001
D. Descriptors:
Advanced nickel electrode
Composite battery electrode
Sintered composite electrode
Fiber composite electrode
Nickel graphite
E. Applications:
Batteries and Fuel cells:
Nickel - cadmium
Nickel - zinc
Nickel - hydrogen
Nickel - iron

7. Potential Support: (exclusive license) consulting (joint venture) drawings, tooling, computer prog., economic study, training, adaptive eng., other: Probable DARPA Program - Advanced Alkaline Submarine Battery

8. What Problem Does It Solve and How? Sintered nickel battery electrodes are heavy, structurally weak and expensive. This process shows the potential for a successful high energy density, electrically durable lightweight nickel composite electrode fabricated by a relatively simple suspension method of active material impregnation.

9. Other Uses: Technology applicable to fuel cells and chloralkali processes.

10. Main Advantages: Optimizes use of nickel, a relatively expensive and critical raw material. Structure provides for good electrode durability, and its high porosity and pore size results in high capacity.

11. Production Information: Not available, R&D level work needed to determine best production methods for structure (plaque) and active material loading.

12. Descriptive Literature: Five references cited in the "Description" of Item 13b.

13a. Literature Available From: Dr. William A. Ferrando, NSWC/WO, Code R32, 202-394-3527
Naval Surface Warfare Center, Silver Spring, Maryland 20903-5000

13b. Description:

Lightweight Nickel Composite Electrode

This product represents the results of several years of NSWC developmental research. A significant advance in energy storage capability of the nickel oxide electrode used in Ni-Cd, Ni-Fe, Ni-Zn, and Ni-H_2 cells, has been achieved by the development of a porous sintered, nickel-plated graphite fiber plaque impregnated by the electrochemical process.

The electrode grid consists of a sintered mat or felt of graphite fibers which are coated with a mixture of nickel and phosphorous. The electrode grid is strong, lightweight, and has good electrical performance.

Single electrode test cells have displayed high working energy densities of 120 to 180 Ah/kg. Lifetimes of 500 to 600 cycles for c rate and greater than 1000 cycles at one half c rate of discharge have been achieved.

Utilization of active material approaches 100 percent in lightly loaded electrodes ($<$ 1.5 g/cc void) and range from 70 percent to 90 percent in those more heavily loaded (1.5 to 2.0 g/cc void). A region of increasing utilization was observed in every case extending sometimes to 200 cycles. With later modification to the method of additive addition, the utilization increase became much more rapid ($\sim$ 10 cycles to $>$ 90 percent utilization).

The nickel composite electrode approach appears to offer promise for a new generation of economical, lightweight nickel alkaline battery systems.

13b. (cont.) Descriptive Literature:

a. W. A. Ferrando, "Performance of Suspension - Impregnated Sintered Nickel Composite Electrodes," Electrochemical Society Technical Notes Article, Vol. 132, No. 10, Oct 1985.

b. W. A. Ferrando, W. W. Lee, and R. A. Sutula, "A Lightweight Nickel Composite Electrode Concept and Feasibility," Journal of Power Sources, Vol. 12, p. 249-269, 1984.

c. W. A. Ferrando, W. W. Lee, and R. A. Sutula, Loading and Utilization of Active Material in Nickel Composite Electrodes: Optimization, NSWC TR 84-122, Naval Surface Weapons Center, White Oak, Maryland, Dec 1984.

d. W. A. Ferrando, W. W. Lee, and R. A. Sutula, The Physical Properties of the Nickel Composite Sintered Plaque, NSWC TR 82-416, Naval Surface Weapons Center, White Oak, Maryland, Dec 1982.

e. W. A. Ferrando, F. P. Flight, and A. L. Lee, Electrochemical Impregnation of Nickel Composite Electrodes, NSWC TR 82-414, Naval Surface Weapons Center, White Oak, Maryland, Aug 1982.

f. Invention Disclosure, Patents #4,574,096 and #4,215,190.

APPENDIX C

NSWC FY88 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commerical Applications
Piezoelectric or Pyroelectronics	70,767	Block Patterning of the Metallization of Polyvinylidene Fluoride Transducers	Fire detection and security systems
Physical Security Devices	4,772,877	Security Indicating Attachment for Safe-Type Apparatus	Security systems
Transducers	4,763,030	Magnetomechanical Energy Conversion	Ultrasensitive magnetostrictive transducer sensors useful in passive listening devices such as hydrophones and pressure sensors
Semiconductors	71,249	Sensitization Pretreatment of Pb-Salt Epitaxial Films for Schottky Diodes by Sulfur Vapor Explosure	IR Sensors
Semiconductors	70,775	Method of Sensitizing Pb-Salt Epitaxial Films for SchottkyDiodes	IR Sensors
Mircowave Electronics	4,733,165	Multimode Resonance Chamber and Method of Determining an Equivalent Single Mode Relaxation Response	Microwave test and evaluation systems
Pulse Power	71,268	High PRF High Current Switch	Microwave applications
Computers	4,728,930	Parallel-to-Serial Interface Adaptor	Data Processing
Computers	70,428	Selective Multimode/Multi-configurable Data Acquisition and Reduction Processor System	Computer test equipment

APPENDIX C (Cont.)

NSWC FY88 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commerical Applications
Computers	69,090	Serial Data Word Processing Arrangement	Computers
Computers	H511 (SIR)	Data Collection System	Data systems
Materials Science	70,043	Ceramic Fiber Thermal Protection Coating	Fire-retardant coatings
Metal/Ceramic Composites	4,722,825	Method of Fabricating a Metal/Ceramic Composite Structure	Ceramic-lined cylinders for automobile engines, rifle barrels
Optics	70,996	Nonlinear Optical Protection Against Frequency Agile Lasers	Filters for laser operators in manufacturing facilities
Optics	70,084	Optical Phase Conjugate Beam Modulator	Modulation components of communication systems and holography
Electronics	70,287	Anisotropic Magnetoresistance Measurement Apparatus and Method Thereof	Non-destructive testing equipment for films
Electronics	70,916	Low Power Liquid Crystal Display Backlight	Electronic displays
Electronics	4,767,998	Active Filter Using Low Gain Amplification Stages	Communication of audio systems
Polymers	71,040	Method of Preparing 2,4,4,5,5,6,6-hexafluoro-2-trifluoromethyl-3-oxaheptane-1,7-diol polyformal	Polymer coatings

APPENDIX C (Cont.)

NSWC FY88 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commerical Applications
Polymers	4,740,579	Synthesis of Dihydroxy-terminated Poly (2,2,3,3,4,4-hexafluoropentane-1,5-diol formal)	Polymer coatings
Polymers	4,740,628	2,4,4,5,5,6,6-Heptafluoro-2-trifluoromethyl-3-oxaheptane-1,7-diol polyformal and method of preparation	Polymer coatings
Pipes & Conduits	4,702,884	Glass-Lined Pipes	Glass-lined pipes resistant to shock
Warfare Nuclear Biological & Chemical (NBC) Warfare	4,725,733	Apparatus and Method for Remotely Detecting the Presence of Chemical Warfare Nerve Agents in an Air-Released Thermal Cloud	Detecting constiuent ingredients in drug manufacuturing
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